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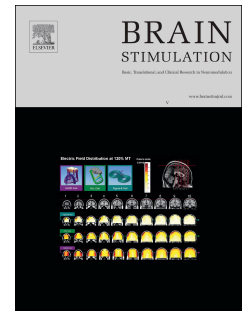
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Letter to the Editor: Automated night-time deep brain stimulation battery checks can induce symptoms: identification and management of a new hardware complication

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Letter to the Editor

Dear editor:

Since the first introduction of deep brain stimulation (DBS) of the ventral intermediate nucleus (VIM) of the thalamus for the treatment of medically refractory tremor [1], worldwide experience with this technique has grown. Continuous thalamic stimulation by DBS systems has replaced thalamotomy as thalamic stimulation has fewer and in parts reversible adverse effects with life changing impact on tremor control [2]. A significant improvement in overall tremor symptoms (ranging from 40% up to 95%), in hand function as well as in activities of daily living (e.g. the ability to eat, drink, write, home maintenance, hobbies etc.) in patients after VIM DBS has been reported by the majority of published studies [3, 4]. Furthermore, long-term follow up (up to 13 years) showed sustained improvements in health related quality of life (HrQoL), tremor control and patient satisfaction [5-7]. However, tolerance may develop in some patients with decreasing effect over time, most noticeable in action tremor, requiring changes in stimulation parameters and sometimes a recommendation to switch DBS off during the night [5, 7]. The benefit to reduce tremor and hereby improve HrQoL needs to be balanced against a rate of 9% to 23% of complications [2, 8]. Most complications are mild and can be resolved by a change of stimulation parameters. More severe events are relatively rare. The most serious complications of VIM DBS are strokes (haemorrhagic, ischemic) and infection [3, 8]. Regarding infection, removal of parts or all of the DBS components with re-implantation if possible at a later date may be required. Other complications can be related to the stimulation itself: paresthesias, pain, dysarthria, contractions, ataxia, gait and balance difficulties are usually reversible with changes of stimulation parameters [9]. Some complications specifically are related to hardware presence, e.g. skin erosions, or due to hardware failure, e.g. lead fracture, electrode migration. The overall hardware-related complication rate is up to 23% [7]. With advancing technology and as experience grows, new complications are described e.g. the shielded battery syndrome [10].

Here we describe a new hardware complication related to the automated checks of the implantable pulse generator (IPG) in a DBS system which caused the rebound of disabling symptoms at time-locked intervals. We describe its symptoms, diagnosis and a simple solution.

A 71 year old man, with a 12 year history of essential tremor underwent bilateral VIM thalamic DBS using a St Jude Medical Libra system. The system was programmed three days after surgery with excellent tremor control. Ever since, however, the patient reported a transient bout of bilateral arm tremor nightly. The tremor would start suddenly and stop spontaneously after 20-30 seconds. It occurred during different activities, e.g. eating dinner, brushing the teeth, or sleeping, which could be interrupted. Additionally, he experienced an electric shock-like paraesthesia bilaterally at the same time. He reported its occurrence at roughly the same time each night.

Testing the IPG for impedance, stimulation parameters, system integrity or infection was unremarkable. The patient denied any home electrical interference, and indeed onset of these symptoms during sleep argued against this. Interestingly whilst on holiday in Europe, the tremor occurred nightly at the local time that was 1 hour different from his home time in the UK. The periodicity, time locked nature, and persistence across international time zones, suggested a hardware technical issue. We considered automated IPG checks as a potential cause and raised this possibility with the manufacturer who provided further information. St Jude Medical Libra IPGs have an inbuilt automated IPG check at a defined fixed nightly time which lasts on average for 0.5 seconds and leads to a transient switching off of the stimulation. In routine clinical practice for IPG testing, turning the IPG off and on can induce transient rebound of tremor and paraesthesia, which lasts a few seconds before abating in some patients. We hypothesised that this automated nightly IPG check was similar, and was the cause of the patients symptoms, with the cessation of current delivery leading to the rebound of bilateral

tremor, and the electric shock-like paraesthesia being due to the automatic switching on of the IPG. With assistance from manufacturer's engineers, the inbuilt automated duration of the nightly check was reduced to the lowest value possible which was 0.02 seconds. This immediately resolved the symptoms of both the rebound tremor and paraesthesia. We assume that the duration of the DBS being switched off for only 0.02 seconds is too short to cause, rebound of symptoms, possibly because it may take longer than this for neural tissue being affected by DBS to return to baseline, and then be influenced by DBS again. The recurrence of symptoms in essential tremor or Parkinson's disease patients is recognised when the IPG is turned off. This can occur after voluntary switching off the IPG, or just transiently during programming of the IPG as the IPG transiently delivers no current. In the latter case occurrence of symptoms usually only lasts seconds with tremor being the first motor symptom to rebound. This can be accompanied by transient electric shocks or other sensory changes in the limb contra lateral to the brain side being programmed. Educating the patients before proceeding to programming is recommended to alleviate concerns.

In systems in which automated IPG checks occur, most patients do not notice rebound symptoms at the time of the automated checks. Rarely, as in the case described here, such a check may result in rebound of symptoms. This notion is evidenced by the resolution of symptoms when the IPG off duration was reduced to the lowest permissible. This is the first published report to illustrate this phenomenon and might therefore guide management of similar patients in the DBS community. This new hardware complication and the technique of resolution should be added to standard troubleshooting strategies if re-encountered.

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Highlights

- deep brain stimulation systems have automated IPG check times which can lead to transient rebound of disabling symptoms like tremor at time-locked intervals and present hereby a new hardware related complication
- automated IPG check times can be reduced by manufacturer's engineers resolving the symptoms of the patients
- recognition of this phenomenon and its effective management will help reduce morbidity associated with DBS therapy